Appendix – South Platte Basin Characterization

This document presents preliminary information about the South Platte basin as part of an implementation plan for streamflow regulation accounting in forecast operations. It is formatted along the lines of the implementation plan to which it is appended and is drawn from the material found in the appendix to a memo dated 26 March, 2004 titled "*South Platte Streamflow Regulation Modeling Strategies*". The primary addition to that document that is presented here is a description of regulation issues for the segments identified in the South Platte forecast group of MBRFC's river forecast system. The attached map shows the segments located in the South Platte basin, upstream of the Julesburg gage. This map can be referenced to identify the locations of segments and their connectivity throughout the river system.

Basin Inventory

Basin Overview

The South Platte River basin has a drainage area of over 23,000 square miles, covering lands in Colorado, Wyoming, and Nebraska. Most of the flows originate from the melting winter snow pack, thus producing large spring and early summer runoff. The USGS has estimated the annual native flows for the basin to be 1,400,000 acre-feet at the Colorado / Nebraska state line. Trans-basin water provides another 400,000 acre-feet, primarily from the Colorado River. Groundwater pumping from high capacity alluvial wells located along the South Platte is estimated to provide approximately 640,000 acre-feet per year. There are about 1,800,000 acre-feet of reservoir storage capacity in the basin. Total annual surface water diversions equal approximately 4,000,000 acre-feet. Consumptive use of river water for human purposes (municipal, industrial, irrigation, etc.) is estimated to be around 1,500,000 acre-feet. Overall, the South Platte River system is over appropriated and highly regulated due to large demand levels placed on the limited water supply. Water is used and reused on average three times before it reaches the confluence with the North Platte.

Regulation Identification

The majority of reservoirs and diversion structures in the South Platte basin are used for delivering water to irrigated lands. Municipal water providers continue to acquire additional water supplies, such as transfers from agricultural use and increased trans-basin imports, as the urban population grows. There are several thousand wells used to pump alluvial groundwater, especially along the lower Platte. Only a limited number of large flood control structures exist in the basin as most reservoirs are used primarily for water supply protection and are located off-channel. In Colorado, the State Engineers Office (SEO) applies the Prior Appropriation Doctrine (first in time ~ first in right) to direct water allocation. Generally, water rights are most senior in the upper tributary basins, while the water rights on the lower mainstem are more junior. Water rights are distinguished as direct flow rights, which require the immediate use of water for beneficial use, and storage rights, which allow water to be stored for an indefinite period. The South Platte River Compact designates the level of allowable diversions on the lower end of the river in the State of Colorado at times when Nebraska water users have unmet demand on the river. The largest diverter in Nebraska is the South Platte Supply Canal, which diverts large volumes for a hydropower facility. In Wyoming there is limited regulation occurring on the Crow Creek and Lodgeple Creek, tributaries to the South Platte. Both Wyoming and Nebraska allocate water on principles similar to Colorado.

Regulators in the South Platte basin (Colorado) consist primarily of agricultural irrigators and municipal water providers. Irrigation accounts for 68% of water use, 22% for municipal use, and 3% for industrial. The remaining 7% is used for augmentation and groundwater recharge.

Although many water rights serving agricultural land are still owned by individuals, these private water rights are often combined under one large structure as a mutual ditch. Therefore, numerous water rights can exist at a single diversion point on the river. There are approximately 625 irrigation diversion structures on the South Platte and tributaries. On average, about 50% of the water diverted for irrigation is consumptively used. The remaining water returns back to the river system or recharges alluvial aquifers. Irrigation practices tend to significantly alter the natural hydrograph by reducing spring and summer flows (diversions) and increasing the winter flows (returns).

Of the municipal water providers, Denver Water is the dominant entity, controlling large amounts of native and trans-basin water supplies. Other water providers with significant control of water supplies include the cities of Thornton, Aurora, Boulder, Fort Collins, and Greeley. Regional water districts, commonly referred to as rural domestics, serve many of the smaller towns. There are approximately 700,000 acre-feet of foothills/mountain reservoir storage controlled by municipalities. There is additional reservoir storage on the west slope (Colorado River Basin) that can provide water to the South Platte basin. Most municipal water providers retain, or carryover, stored water during average and wet years so as to be available during drought periods.

There are federally owned and operated regulation structures in the South Platte basin but compared to the private sector they do not play a significant role in terms of overall impact on basin streamflows. The Bureau's Colorado – Big Thompson (CBT) project imports up to 300,000 acre-feet from the Colorado River to the South Platte. There are three Federal flood control structures on the South Platte; Cherry Creek, Chatfield, and Bear Creek reservoirs.

The SEO oversees the actual allocation of water from the river system and is responsible for enforcing the principles of the prior appropriation doctrine. The South Platte basin is divided into 14 separate administrative districts. Each district has a water commissioner who manages the flow levels at diversion structures. The commissioner considers such things as the estimated natural flow levels, return flows throughout the river reach, downstream calls, reservoir deliveries, augmentation requirements, and other types of restrictions, etc. when determining the legally available diversion rates. It should be noted that most of the alluvial wells are administered similar to surface water rights, and that during low flow periods, groundwater pumping may be restricted. A direct flow water right has a date of appropriation and an upper diversion rate. Rarely are volumetric limitations placed on a direct flow right, so long as the water is being placed to a beneficial use. Although many states require a minimum "bypass" flow at diversion structures, water users in Colorado are generally allowed to divert the entire flow of the river if it is within their water right. The earliest adjudicated water rights date back to the 1850's. In the South Platte, a water right dated 1880 or later is considered a mid-junior water right and may not yield water during dry seasons. Many junior water rights only yield water during the peak runoff periods. Storage water rights have a date of appropriation as well as an annual volume restriction that is usually based upon the physical capacity of the storage reservoir. Storage rights generally do not have a maximum diversion rate restriction. The SEO operates on a November – October water year, different from the USGS October – September water year.

Information Collection

Mainstem diversion records for both privately and publicly owned regulation structures have been acquired through the SEO databases and other agency documents. The main source for streamflow

data is the USGS, but additional streamflow gages are monitored by the SEO and Nebraska Department of Natural Resources. Descriptions of system operations and decision-making processes for most regulators (e.g., Denver Water, Water Supply and Storage Company, Central Water Conservancy District) are not readily available and have been requested from the particular entity as needed. Although most regulators have been willing to share information, some entities have not responded to requests.

The quality of the SEO data is generally quite good for post 1970 observations. Earlier data is somewhat suspect and requires quality review. Most of the data are available on a daily time step, although inspection of data suggests that quite often daily flows were derived from weekly or monthly observations. Reservoir storage contents are usually only recorded on an end of month basis.

Data corresponding to system operations beyond the original diversion structure are usually not publicly available. For example, the SEO will record flows off of the river, but does not track the final delivery point. This level of information may be maintained by the entity diverting and using the water, but often times it is difficult to access this information. Many smaller organizations (ditch companies) still keep records in hard copy format.

The main challenges in this task have been overcoming the problems posed by varying levels of data quality, different formats, and various time-steps for data reporting.

Information recording the administration of the river is available through the SEO river "call records". These records are helpful in understanding which water rights were in priority throughout the course of the water year. In addition, other types of administrative records such as river exchanges, augmentation releases, groundwater pumping restrictions, and compact deliveries provide important information describing the operations in the river. Interviews with administrative officials such as division engineers and district water commissioners may still be required in order to fully understand management issues in particular river segments. For example, the record drought of 2003 forced the curtailment of groundwater pumping throughout the South Platte basin. This extreme administrative action had never before occurred.

The larger regulators publish periodical annual operating reports that provide insight into their operations. This type of information has been acquired for the federally operated projects. The Bureau's annual operating plan for the Colorado – Big Thompson project provides information concerning the coordinated operation of the project. It contains a summary of operations as well as several tables containing observed flows and reservoir levels. Obtaining this type information from private entities, especially those involved in power production, has proven more difficult.

Information concerning both basin administration and operation is often anecdotal in nature. Many arrangements exist between water users, such as water exchanges, that are informal and undocumented. Although these arrangements are indeed a form of streamflow regulation, they do not appear in any type of official database and would not be revealed by analyzing historic diversion records. These types of operational arrangements and agreements exist throughout most basins and have posed major difficulties when trying to draw objective conclusions based upon time-series data analysis.

Many of the reports that we have acquired contain detailed hydrologic studies that would not be practical to reproduce within the scope of AHPS. A good example is the calculation of naturalized, or virgin, flows at selected gaged locations throughout the basin. We have obtained naturalized flow data for several sites on the South Platte mainstem, Boulder Creek, the Big Thompson River, and the Cache la Poudre River. These studies were directed by either municipal water providers or the state

agencies. Most of these studies have been performed on a monthly time step, although some have been developed on a daily time step going back close to 30 years. In any case, such reports can be a tremendous time saver when performing quantitative analyses on the NWSRFS segments.

Many of the larger regulating structures in the South Platte convey water from one stream segment and deliver it into another. This type of intrabasin water transfer is fairly common in water short areas such as Colorado. Maps and GIS are necessary to track the movement of water throughout the basin.

High Level Basin / Segment Characterization

The South Platte basin has an obvious delineation between the upper (mountains and foothills) and lower (plains) portions of the basin. The upper basin is characterized by many storage reservoirs, interbasin and transbasin conveyance structures, and more senior water rights. The water rights and storage vessels located in the upper basin are predominately owned and controlled by municipal water providers. The main reasons are good water quality and good reservoir sites. On the other hand, the lower basin is generally controlled by agricultural interests and is characterized by numerous diversion structures, extensive canal delivery systems, and off-river storage reservoirs that serve as both a source of supply late in the summer and as a regulating mechanism on the canal system. Limited amounts of groundwater pumping occur in the upper portion, while the lower reaches of the South Platte are significantly affected by pumping. Water quality in the lower South Platte is too poor of quality to be economically treated for potable use at this time.

Segment Descriptions

Upper South Platte

Following is a list of tributaries and segments in the Upper South Platte basin.

South Fork of the South Platte: ANRC2/SPAC2
Tarryall Creek: TRKC2, ALLC2
North Fork of the South Platte: RBTC2, GRNC2, NFSC2
Plum Creek: LOVC2
Bear Creek: MRRC2, BCDC2, SHRC2
Cherry Creek: FRKC2, EDGC2
Clear Creek: IDOC2, GLDC2, DRBC2
Sand Creek: SACC2
South Platte River: SASC, SPYC2, EVNC2/SELC2, CHEC2/DKRC2, SPTC2, WATC2, CFDC2, ENWC2, DNVC2, HNDC2

South Fork of the South Platte

ANRC2/SPAC2 - Antero Reservoir/So. Platte R. below Antero Reservoir

Area: 218 mi^2
Irrigation: 1,282 ac
Upstream: none
Downstream: SASC2

Description

This is a proposed headwater basin at the uppermost end of the South Fork of the South Platte River. It is assumed, after inspection of USGS maps and the State of Colorado's Hydrobase database, that the proposed SPAC2 segment refers to the gage shown on maps immediately downstream of Antero Reservoir. That gage measures only reservoir releases; therefore the two proposed segments are described jointly here. The western part of this basin extends into the high mountains along the Continental Divide, to elevations above 4,000 meters. Snowmelt is the major component of basin runoff. Mountain sideslopes are forested, dominantly with coniferous species. At lower elevations, extensive agricultural acreages (irrigated hayfields) occur on the relatively flatter floor of South Park (a major topographic region of Colorado). The human population is sparse.

Antero Reservoir was built in 1909, and has a storage capacity of 20,000 acre-feet. The high water line is at an elevation of 8,978 feet. The reservoir is owned and operated by Denver Water (DW); its sole management objective is municipal water supply. Average annual releases are approximately 25 cfs (18,000 acre-feet).

The Natural Resources Conservation Service (NRCS) maintains several snow courses in the basin and nearby vicinity. DW monitors the reservoir releases and pool elevations; the Colorado Hydrobase information indicates that End-of-Month (EOM) data exist from 1974. A climatic data station is operated at the reservoir - which parameters are measured is unknown, but these are anticipated to be pan evaporation, precipitation, and temperature. Climatic data are apparently available from 1961 - 2003 at Hartsel, CO. Other climatic stations occur in the region.

The availability of historical reservoir time series at a daily or shorter time step is unknown, but the U.S. Army Corps of Engineers (USACE) does maintain a stream gage "near Hartsel", which appears on database maps as being at or near the reservoir outlet gage. The availability of real time data is unknown, but DW may be able/willing to provide them. Further communication and cooperation with Aurora, DW and USACE is recommended. It is probable that the agencies possess more continuous daily data.

Major Issues

Under typical operations, the reservoir captures spring and summer runoff (dominantly snowmelt) to be released as a supplemental municipal supply. The reservoir stores water in accordance with the administration of water rights, following the doctrine of prior appropriation. In recent years, the cities of Aurora and Thornton (Denver suburbs) have been aggressively pursuing water rights acquisitions in South Park, and this may affect inflows and storage releases from Antero Reservoir. The South Fork of the South Platte is joined by tributary creeks as it flows toward the reservoir. A diversion ditch from the South Fork crosses over into High Creek in the downstream local area (SASC2), at a point representing about half of the ANRC2 basin area. Ownership and diversion rates for this ditch system are currently unknown. It is possible that the City of Aurora has obtained the related rights to enhance inflows to Spinney Reservoir downstream.

The releases from Antero Reservoir are probably not consistent with the more predictable patterns of flood control operations elsewhere. As such, municipal demands, water rights administration, and water exchanges are anticipated to complicate the reservoir modeling.

Tarryall Creek

TRKC2 - Tarryall Creek below Rock Creek

Area: 227 mi^2
Irrigation: 5,643 ac
Upstream: none
Downstream: ALLC2

Description

This is a proposed headwater basin on the eastern side of South Park, a relatively flat, open grassland area between mountain ranges in central Colorado. The watershed consists of comparatively flat grasslands at lower elevation, bounded on all but the southwest by mountains covered with coniferous forests or alpine tundra. Lower elevations are on the order of 9,000 to 9,700 feet and higher elevations range upward to approximately 13,800 feet.

The basin is drained by Tarryall Creek, Michigan Creek, Jefferson Creek, Snyder Creek, Rock Creek, and a number of smaller gulches, all of which form a fairly regular dendritic pattern. Jefferson Lake is a small body of water located in a mountain cirque in the extreme northeast part of the watershed at an elevation of about 9,900 feet. It has a capacity of 2,170 acre-feet according to the Forest Service, but is not known to be actively regulated. The Boreas Pass Ditch crosses the high mountain range in the west-central part of the basin divide, importing flows from near Breckenridge, CO. In the last 20 years or so, the time series data indicates the ditch has been dry most of the time. Small flows (less than 3 cfs) have occasionally been measured on the ditch. Additional information indicates that the Boreas Pass Ditch carried an average of 139 acre-feet per year from 1990 - 1999, including years of no diversions. The Tarryall Creek stream gage itself was operated from January 1983 through December 1997. Flows of up to about 700 cfs were recorded, but the annual average flow was about 52 cfs. Other locations further upstream on Tarryall Creek have been occasionally monitored.

The stream gage at TRKC2 was in operation from January 1983 through December 1997. Daily historical flow data are available. The station apparently was discontinued after that time.

Major Issues

A number of other diversions exist in the vicinity, such as the Borden Ditch, and additional ditches across Boreas Pass. These have senior rights owned by the cities of Denver, Aurora, Thornton, and Englewood. A number of ranch diversions also exist; rights to these have probably been purchased by the cities in recent years. Only general diversion information (e.g. acre-feet per month for 1 to 4 recent years) is available for these structures in the Hydrobase database. Additional inquiries would need to be made to further identify diversion rates and locations. It is also possible that small imports occur from diversions along Beaver Creek in local area SASC2.

Of greater concern is that the gage representing the selected local area appears to have been discontinued at the end of 1997. Sufficient daily historical flow data probably exist to allow calibration of the basin.

ALLC2 - Tarryall Reservoir

Area: 104 mi^2
Irrigation: 231 ac

Upstream: TRKC2
Downstream: Zone 3202

Description

This proposed local area is located on the eastern edge of South Park, a relatively flat, open grassland area between mountain ranges in central Colorado. The watershed consists of comparatively flat grasslands at lower elevation, bounded on the west, north and east by mountains covered with coniferous forests. Lower elevations are on the order of 8,800 to 9,000 feet and higher elevations range upward to approximately 11,900 feet. The basin is drained by Ruby Gulch (a tributary) and Tarryall Creek. The latter flows southeastward to meet the South Platte River above Cheesman Reservoir.

Tarryall Reservoir is a small facility operated by the Colorado Division of Wildlife (DOW). The Division has water rights junior to the cities of Denver and Aurora, so the reservoir is usually not filled. The reservoir was closed and drained in April, 2002. Prior to that, several cracks in the dam allowed seepage to pass. DOW is required to meet a downstream minimum flow level for fisheries. This is currently set at 14 cfs by the Colorado Water Conservation Board.

Whether times series area available requires further investigation. Currently no time series for pool elevation is known to exist. Fragmented daily data exist for Tarryall Creek below the reservoir in Colorado's Hydrobase, for the period June 1975 through September 1980. Typically these data are in segmented periods of 6 or 8 months each during the spring through fall. Flows are quite variable, ranging from 0.0 to over 600 cfs.

Major Issues

There is considerable disagreement on the storage capacity of Tarryall Reservoir. Colorado's Hydrobase information identifies the reservoir's storage capacity as 107,000 acre-feet. (This is obviously incorrect - that would make it approximately 10,000 acre-feet larger than Cheesman Reservoir.) Other various Internet sources identify the reservoir storage capacity as being approximately 26,000 acre-feet (EarthIsland), 7,217 acre-feet (Colorado Water Conservation Board), 2,445 acre-feet (U.S. Forest Service), 1,963 acre-feet (Colorado Water Conservation Board - Dam Safety), and 1,200 acre-feet (Water Commissioner Mike Eytel). The DOW lists the reservoir surface area as 886 acres, but USGS topographic maps indicate that the pool area is more likely to average 88.6 acres. (It is possible that the surface area varies considerably with even slight filling.)

North Fork of the South Platte

RBTC2/GNRC2 - Roberts Tunnel/N.F. S. Platte below Geneva Cr.

Area: 124 mi^2
Irrigation: none
Upstream: none (tunnel imports)
Downstream: NFSC2

Description

This is a proposed headwater basin that also receives transmountain imports from the Roberts Tunnel (RBTC2). The basin consists of mountainous high-elevation coniferous forests and alpine areas. Much of the area is above timberline. Elevations range from about 8,600 feet to 14,200 feet, with an average of about 11,000 feet. The North Fork of the South Platte River is the major drainage. It is

gaged downstream of the small settlement at Grant, downstream of the Geneva Creek tributary and approximately 1.5 miles downstream of the tunnel mouth.

The Roberts Tunnel imports water from Dillon Reservoir on the West Slope. It is gaged by the Bureau of Reclamation, and imports have averaged about 69,000 acre-feet per year (95 cfs) over the period 1990 - 1999. Daily flow values are available, and possibly shorter interval data as well. The North Fork of the South Platte was gaged by USGS from 1909 through September, 1998. The gage is now maintained by the U.S. Army Corps of Engineers (USACE). Daily flow values are available.

Major Issues

None.

NFSC2 - N.F. S. Platte R. abv. Elk Cr. at Pine

Area: 353 mi^2
Irrigation: 750 ac
Upstream: GNRC2
Downstream: SPTC2/Zone 3209

Description

This proposed local area consists of forested mountains at elevations ranging from about 6,750 to 13,600 feet, with a mean elevation of about 9,400 feet. In addition to basin runoff, the stream gage measures transmountain imports down the North Fork via the Roberts Tunnel. The tunnel was completed in 1962. The 1990-1999 average annual importation through the tunnel was approximately 69,000 acre-feet (95 cfs).

Major Issues

This site has very limited time series available for calibration. The time series only extends from October 2000 through December 2002, and about half the data are missing. It is not known if the station will be continued by the State of Colorado. USGS is not monitoring at the location.

Plum Creek

LOVC2 - Plum Creek at Louviers, CO

Area: 275 mi^2
Irrigation: 16 ac
Upstream: none
Downstream: CFDC2

Description

This is an existing headwater basin consisting of foothills, mesas, and plains. Most of the area consists of grasslands and brushy hillslopes. Elevations range from about 5,720 to 9,750 feet, with an average of about 7,030 feet. Plum Creek contributes flow to Chatfield Reservoir storage.

Plum Creek is gaged by the USGS at Titan Road near the town of Louviers, and also upstream at Sedalia. Both gages have data through the present; the Titan Road gage data begin in 1984, and the

Sedalia gage data begin in 1942. An additional USGS gage near Louviers has data from 1947 through 1990.

Major Issues

None. Highlands Ranch apparently has junior decreed rights (1979, 1985) for 17,000 acre feet of Plum Creek water for its Reservoirs Nos. 6 through 11. However, these apparently have not been built.

Bear Creek

MRRC2 - Bear Creek at Morrison

Area: 163 mi^2
Irrigation: none
Upstream: none
Downstream: BCDC2

Description

This existing headwater segment consists of mountains, foothills and canyons vegetated with brush, coniferous forest, and alpine tundra. The elevation ranges widely, from about 5,800 feet to 14,300 feet, with an average of about 8,900 feet. For the period 1980 through 2002, the average annual flow was 53 cfs (about 38,500 acre-feet per year). Bear Creek is diverted for municipal supply for the towns of Evergreen and Morrison, as well as for smaller communities, ponds, and pasturelands. Return flows enter the channel above the gage, due to the topography of the bedrock ridge system across the drainage at Morrison.

The basin is gaged by the USGS at Morrison. Daily data are readily available.

Major Issues

None.

BCDC2 - Bear Creek Reservoir

Area: 81 mi^2
Irrigation: none
Upstream: none
Downstream: SHRC2, SHRC2DIV

Description

This is an existing local area that consists of rolling hills and grasslands at elevations between about 5,500 and 10,600 feet. Brush and coniferous forests exist at the higher elevations. The average elevation is about 7,300 feet. The major feature of the basin is Bear Creek Reservoir (Bear Creek Lake), which is a flood control and recreational facility operated by the U.S. Army Corps of Engineers (USACE). The City of Lakewood cooperates with USACE to operate the recreational facilities.

Bear Creek Lake was built in 1982. The multi-purpose pool has a surface area of 110 acres and a storage capacity of 2,000 acre-feet. The flood control pool has a surface extent of 718 acres and a maximum capacity of 78,000 acre-feet. The normal outlet consists of a 7-foot diameter conduit with a rated capacity of 2,000 cfs. The emergency overflow spillway has a rated capacity of 153,500 cfs.

The USACE monitors Bear Creek Lake for hourly pool elevation. Historical outflow data are not currently known to exist, but could be derived for a short period of record through a reservoir water balance approach. The USGS collects data at a station on Bear Creek just upstream of the reservoir, and formerly collected data on Turkey Creek (a tributary to the reservoir). These data, which would closely represent reservoir inflows, overlap in 1986 through 1989. As an alternative, either the upstream gage data (or the downstream gage data at SHRC2) could be proportioned to represent historical reservoir inflows (or releases) for calibration. However, this approach may not be adequate to solve the real-time data issue for forecasting purposes. Furthermore, the potential use of other gaging data is complicated by diversions and returns (see SHRC2DIV). This is a complex segment where more investigation into time series availability and the variation in reservoir operation would need further analysis.

Major Issues

Diversions occur above and below Bear Creek Reservoir (see SHRC2DIV). No reservoir outflow data are known to exist.

SHRC2 - Bear Creek at Sheridan

Area: 23 mi^2
Irrigation: none
Upstream: none
Downstream: SASC2

Description

This is an existing local area in the current forecast system. The basin consists of lower-elevation hills and valleys; much of the area is urbanized. Elevations range from about 5,300 to 6,500 feet, with an average of 5,560 feet. The average annual gaged flow for the period 1980 through 2002 was approximately 63 cfs (about 45,600 acre-feet per year).

A number of smaller reservoirs and ponds (e.g., Kendrick Lake, the Ward reservoirs, Harriman Lake, and others) occur within the local area. Many of these receive water diverted from Bear Creek, but others retain runoff from small tributaries. Marston Lake, a 20,000 acre-foot capacity water supply reservoir owned by Denver Water (DW), also is located in the watershed. Marston Lake is mainly supplied by pipeline from the South Platte River above Waterton (WATC2), and its discharges, if any, typically enter Bear Creek above the SHRC2 gage before re-entering the Platte. A portion of Marston Lake discharge may be carried back upstream to the Platte at the Chatfield Reservoir spillway (CFDC2) by a separate pipeline.

Marston Lake inflows, outflows, and pool elevations are monitored by DW at a daily or shorter time interval. The Bear Creek at Sheridan gage is monitored by USGS; daily data are readily available.

Approximately 110 headgates and 70 small reservoirs and ponds have decreed rights along the entire length of Bear Creek, but most either do not divert significantly and/or do not maintain diversion records. Many of the returns occur to Bear Creek above the mouth, and thus can be modeled at the

MRRC2, BCDC2 and SHRC2 locations before entering the South Platte. However, some large diversions may be consumed as water supplies or losses from small reservoirs, or routed to the South Platte further downstream. In addition, a number of small ponds retain runoff from small tributary drainages within the basin.

Time series data exist for the main channels (Bear Creek and the South Platte) throughout the vicinity. Also immediately downstream is the USGS gage on the South Platte River at Englewood (06711565), located just below the South Platte/Bear Creek confluence immediately downstream of ENWC2 and SHRC2. This gage is not an existing or proposed segment, but daily data collected at the site may be used for water balance review. Of the diversions for which any data are available, annual average rates totaling approximately 22,500 acre-feet per year were recorded recently (i.e., within the last ten years or so). Much of this information is based on significantly limited data, and the actual rates are probably higher. Major diverters for which data (however limited) are available include Marston Lake (Denver Water), the Ward Reservoir system, the McBroom Ditch, the Arnett-Harriman Ditch and the Warrior-Harriman Ditch.

Major Issues

There are a large number of diversions and returns along Bear Creek, and many of these occur downstream of Morrison (MRRC2) as well as above Bear Creek Reservoir (BCDC2). Forecasting continuity with the upstream segment (BCDC2) is apparently complicated by the lack of reservoir outflow data in real-time.

Cherry Creek

FRKC2 - Cherry Creek at Franktown

Area: 158 mi^2
Irrigation: 51 ac
Upstream: none
Downstream: EDGC2

Description

This existing headwater segment consists of lower-elevation mesas, hills, and more extensive grasslands. Brush and occasional conifer stands occur on sideslopes. Elevations range from about 6,160 to 7,700 feet, with an average of about 7,080 feet. The human population is sparse. For the period 1980 through 2002, the average annual streamflow was approximately 11.5 cfs (about 8,240 acre-feet per year). The USGS publishes daily flow data for the gage at Franktown.

Major Issues

None.

EDGC2 - Cherry Creek Reservoir (Lake)

Area: 212 mi^2
Irrigation: 42 ac
Upstream: FRKC2
Downstream: DNVC2

Description

This is an existing local area segment that represents a U.S. Army Corps of Engineers (USACE) flood control reservoir in the southeast Denver metropolitan area (Aurora). The basin consists of mesas, rolling hills and grasslands. Brush and isolated conifer woodlands occur on the slopes. The elevation ranges from about 5,500 feet to 6,800 feet, with an average basin elevation of about 6,150 feet. Historically, settlement was sparse and consisted mainly of ranches and farms. In recent years Denver suburbs such as Parker, Cottonwood, and other developments have increasingly urbanized the watershed. The average annual flow below Cherry Creek Lake for the period 1980 through 2002 was approximately 13.2 cfs (9,560 acre-feet per year). In some years, the historical annual average flow has been zero. The recorded maximum mean annual flow was 47.8 cfs (34,640 acre-feet per year) in 1984.

Cherry Creek Lake was completed in 1950 for the main purpose of flood control. It is also extensively used for recreation. The capacity of the multi-purpose pool is about 14,000 acre-feet, with a surface area of 850 acres. The maximum storage capacity is about 134,500 acre-feet, with a surface extent of 2,630 acres. The normal outlet has four gates opening to two conduits, with a rated capacity of about 8,000 cfs at the original spillway crest elevation of 5,598 feet. An ogee-crest spillway was planned to be constructed at an elevation of 5,623 feet. It is not currently known if this structure was built. The original overflow spillway was rated at about 12,000 cfs at a pool elevation of 5,620 feet.

The USACE monitors hourly pool elevation at the reservoir. The USGS maintains a stream gage immediately below the reservoir, and daily outflow data as well as real-time data are readily available.

Major Issues

There are on the order of 80 decreed diversions on Cherry Creek between the Franktown gage (FRKC2) and Cherry Creek Reservoir. None of these have diversion records available, and many were transferred over to well pumping rights in the late 1970s. The major ditch system along the stream is the Arapahoe Ditch, for which no information is readily available. It diverts from the stream immediately below FRKC2.

Clear Creek

IDOC2 - Clear Creek at Lawson

Area: 154 mi^2
Irrigation: none
Upstream: none
Downstream: GLDC2

Description

This existing headwater segment consists of alpine zones and coniferous forests in the steep mountains west of Denver. The elevation ranges from about 8,000 to 14,200 feet with an average of 11,200 feet. Clear Creek and its tributaries are the major drainages. Transmountain imports are introduced into Clear Creek in this headwater basin. Gage records indicate that the average annual flow at the station for the period 1980 through 2002 is approximately 94.6 cfs (about 68,500 acre-feet per year).

The Gumlick Tunnel (Jones Pass Tunnel) and the Vasquez Tunnel are located at the very western edge of the watershed at elevations of approximately 10,400 feet. Both are owned by Denver Water (DW). The Gumlick Tunnel was completed in 1940 and has a capacity of 550 cfs. It brings water to Clear Creek from the Williams Fork Basin on the West Slope. The Vasquez Tunnel is located on Clear Creek immediately downstream of the east portal of the Gumlick Tunnel, and transfers most of the diversion northward into the Fraser River basin where it then flows into South Boulder Creek via the Moffat Tunnel. The Vasquez Tunnel also has a capacity of 550 cfs. From 1990 through 2000, the Vasquez Tunnel carried all of the Gumlick Tunnel diversion northward in 8 out of the 11 years. The mean annual diversions for 1990 through 1999 were 2,070 acre-feet. In 2000, the diversion was 2,781 acre-feet. In 3 of the years, water was allowed to flow down Clear Creek.

The Berthoud Pass Ditch was purchased by the cities of Northglenn and Golden in the 1980s. It typically imports in June and July, with an average annual yield of about 950 acre-feet. It delivers water to the West Fork of Clear Creek above the Lawson gage. The Straight Creek Tunnel also collects water from the West Slope, and transfers it via the Eisenhower Tunnel to Clear Creek above Lawson. Imports began in 1973. Recently it has typically transferred about 350 acre-feet per year to the Adolph Coors Brewing Company in Golden. The Vidler Tunnel is owned by the City of Golden, and transfers water into Leavenworth Creek, a Clear Creek tributary above Lawson. Recently the average annual diversion has been about 650 acre-feet. Imports via the Vidler Tunnel began in 1969.

The USGS maintains the streamgage at Lawson; daily data are available. In addition, in recent years the USGS has established a number of gages on high-elevation tributaries of Clear Creek. Typically 4 to 6 years of daily data are available at these locations. Carefully selected time series data such as these may be useful in reviewing calibrations of the high-elevation portions of the watershed.

Major Issues

Transmountain imports somewhat complicate simulations in this existing headwater basin. However, the portion of the gage flow that is represented by imports appears to be small.

GLDC2 - Clear Creek at Golden

Area: 245 mi^2
Irrigation: none
Upstream: none
Downstream: DRBC2, GODDIV

Description

This is an existing local area that consists of both foothills and higher mountains. Vegetation typically consists of coniferous forest, although alpine tundra occurs in the highest mountain areas. Brushy sideslopes occur in lower zones near Golden. Elevations range widely, between about 5,700 feet to 13,900 feet, with an average elevation of 9,200 feet. Clear Creek is the major drainage. A number of small mines and former mining towns exist in the area. Average annual gaged flows for the period 1980 through 2002 are about 197 cfs (142,800 acre-feet).

Clear Creek is gaged at Golden upstream of almost all diversions recorded for the stream. The USGS maintains the gage; daily data are readily available. Additional data are available for Clear Creek at Idaho Springs upstream. That data may be useful in water balance reviews or other modeling considerations.

Major Issues

None.

DBRC2 - Clear Creek at Derby

Area: 176 mi^2
Irrigation: 38 ac
Upstream: GLDC2, GODDIV
Downstream: HNDC2

Description

This existing local area consists of forested foothills, grasslands, and extensive areas of urban development, notably the cities of Arvada and Wheatridge. Elevations range from about 5,100 feet to 10,300 feet, with an average basin elevation of 6,600 feet. Ralston Creek, Van Bibber Creek, Leyden Creek, Little Dry Creek, and Lena Gulch are the major tributaries within the Clear Creek drainage in this local area.

The Clear Creek drainageway widens significantly as it leaves the mountain front below Golden and reaches the South Platte River at Denver. Along the way, a large number of gravel pits and ponds occur in the floodplain. Near the confluence with the South Platte, numerous small farms are interspersed with light industrial zones, and it is likely that wells are scattered throughout the area. Because of these features and the irrigation diversions mentioned below, channel losses and gains may occur during different seasons. The mean annual flow at Derby for the period 1980 through 2002 is approximately 101 cfs (73,000 acre-feet per year).

The Colorado Division of Water Resources maintains the gaging station at the mouth of Clear Creek at Derby. Daily streamflows are readily available for that location. Summary diversion data (monthly historical information) is available for the larger users.

Major Issues

A large number of diversions occur immediately downstream of the streamgage at Golden (GLDC2). Historically, these have been oriented toward a mix of industrial, urban and agricultural uses. The major diverters and their approximate annual average diversions include:

- Coors Brewing Company (48,000 acre-feet per year),
- Standley Lake and associated Westminster uses (38,000 acre-feet per year),
- Farmers Highline Canal (35,000 acre-feet per year),
- Thornton and Northglenn (15,000 acre-feet per year),
- Croke Canal (15,000 acre-feet per year),
- Church Ditch (11,000 acre-feet per year),
- Clear Creek/Platte River ditch system (10,000 acre-feet per year).

- Agricultural Ditch (8,100 acre-feet per year)
- Fisher Ditch (7,550 acre-feet per year)
- Colorado Agricultural Ditch (5,400 acre-feet per year)
- City of Golden (3,500 acre-feet per year)

A number of other users, typically agricultural or municipal entities, divert between 500 and 2,000 acre-feet per year. In general terms, on average roughly 225,000 acre-feet per year have been diverted from Clear Creek between Golden and Derby in the past 15 years or so. Obviously, much of this water consists of return flows that are re-used elsewhere within the system, and/or overlapping records between the main canals and their laterals. For example, the Farmers Highline Canal feeds Standley Lake. Of note is that some of these diversions do leave the local area and return downstream elsewhere on the South Platte system. For example, Standley Lake discharges into Big Dry Creek, which feeds a number of agricultural ditches before returning to the South Platte near the town of Fort Lupton.

Based on these factors, deriving native flow estimates for the local area will be a challenge.

Sand Creek

SACC2 - Sand Creek near Commerce City

Area: 179 mi^2
Irrigation: 14 ac
Upstream: none
Downstream: HNDC2

Description

This is a proposed headwater segment on the plains north and east of the Denver metropolitan area. Sand Creek flows northwestward, joining the South Platte River roughly halfway between the river gages at Denver (DVNC2) and Henderson (HNDC2). Elevations in the basin range from about 5,130 to 6710 feet, with a mean elevation of about 5,760 feet. Major tributaries to Sand Creek include Westerly Creek, Coal Creek and Toll Gate Creek. The mean annual flow at the gage at the mouth of Sand Creek was 56 cfs (40,600 acre-feet per year) for the period 1993 through 2002.

The Burlington Ditch (see HNDC2) intersects the creek just upstream of the river. It is not clear whether the culvert for the ditch actually functions, or if part of the Sand Creek flow enters the ditch without contributing to the river. The gage for Sand Creek is located about 0.2 miles upstream of the ditch. The Highline Canal (see WATC2) and its laterals traverse the Sand Creek watershed and cross the channel by siphons or flumes. Consumptive uses probably minimize the effects of any returns on the streamflows.

The USGS maintains the streamgage at the mouth of Sand Creek. Daily and real-time data area available. Denver Water may be able to provide more information on diversions and returns related to the Burlington Ditch and the Highline Canal. Further investigation into the operation of Aurora Reservoir, available data, and effects on Sand Creek flow is warranted.

Major Issues

In the mid-1990s, the City of Aurora constructed Aurora Reservoir (33,000 acre-feet capacity) as a municipal supply source on Senac Creek, a tributary of Coal Creek. This has withdrawn part of the Sand Creek watershed. The outlet structure and supply infrastructure operations are not currently known. It is not currently known if this facility warrants its own segment definition.

Less than ten diversion rights are decreed along Sand Creek, and most have very junior appropriations for small amounts. However, the Burlington Ditch has a senior right for 250 cfs. No diversion records from the creek are available.

South Platte River

SASC2 - So. Platte River above Spinney Reservoir/Zone 3227

Area: 475 mi^2 (SASC2, 3227)
Irrigation: 1,282 ac
Upstream: none
Downstream: SASC2

Description

This is a proposed local area in South Park, which is a broad, relatively flat topographic feature between mountain ranges in central Colorado. The contributing area extends to high mountain ranges on the west side of the park, but is dominated by meadows and rolling hills. In the mountains, elevations of 3,000 to over 4,000 meters occur. On the park floor, elevations typically range from 2,600 to 3,000 meters. Snowmelt forms the major runoff component. Irrigated hay fields and native pastures are the dominant agricultural land uses. Coniferous forests and alpine tundra occur on the mountain sideslopes. The SASC2 area itself occupies 370 square miles.

Most of the SASC2 flow enters the South Platte River via High Creek, Fourmile Creek, and the Middle Fork of the South Platte. These streams flow southeastward, paralleled by extensive irrigated hay fields and ditch systems. A contributing headwater zone (#3227) occurs to the south of the SASC2 basin. Zone 3227 occupies approximately 105 square miles of lower elevation meadows along Agate Creek, which is ungaged and flows northward to the river. The South Platte flows west to east along a relatively short reach dividing SASC2 and Zone 3227, which lie elongated north and south of the river, respectively. Contributions from both areas are represented at the SASC2 gage. Flow at the gage ranges from a February low of 5.5 cfs to a June high of 231 cfs, with an annual average of 51.8 cfs.

The East Hoosier and West Hoosier Ditches divert water from the Blue River (Colorado River basin) into the Middle Fork of the South Platte River, which is located in this proposed local area. Diversions flow approximately 1.5 miles through the Hoosier Tunnel into Montgomery Reservoir, which is located in the headwaters of the Middle Fork of the South Platte at the very northern end of the SASC2 watershed. The reservoir has a capacity of 4,900 acre-feet and a spillway elevation of 10,861 feet. The reservoir is also decreed to store water from the South Platte River basin. From Montgomery Reservoir, the diversions are piped 70 miles via the Montgomery Pipeline across South Park and into Fountain Creek near Colorado Springs. The entire Hoosier/Montgomery diversion and transport system is now owned and operated by the City of Colorado Springs.

The 1990-1999 average annual yield from the Blue River portion of the project was 9,939 acre-feet, while diversions from the South Platte were 1,401 acre-feet. Year 2000 diversions were 1,401 acre-feet and 386 acre-feet from the Blue River and South Platte portions, respectively.

Daily flow values are available for the SASC2 gage. It is believed that a daily time series or at least monthly averages over time can be obtained for the Otero Pipeline from the City of Aurora. Climatic data are apparently available from 1961 - 2003 at Hartsel, CO. Other climatic stations (including NRCS SNOTEL sites and snow courses) occur in the region.

Major Issues

A large number of ranch diversions have existed historically in this proposed segment. Flow contributions via the crossover ditch from ANRC2 into High Creek are unknown. Other major upstream ditches contributing to the gage include Big Thompson, Fehringer No. 1, Reinecker and Bathouse. These latter diversions are internal to the local area. Diversions from the river occur from the Fritz, Harrington-Rickard, Harrington South, Western, and Central ditches. These bypass the SASC2 gage, but return to the river above Spinney Reservoir in the SPYC2 local area/reservoir segment just downstream. Ownership and diversion rates for these ditches are unknown, but the areal extent of irrigated lands is quite limited between the SASC2 gage and Spinney Reservoir. It is also possible that these ditches no longer divert: Aurora has been aggressively pursuing agricultural water rights in the area for conversion to municipal supply.

In addition, the City of Aurora operates the Homestake Project, which diverts West Slope water from the Frying Pan - Arkansas River system into Spinney Reservoir. Transmountain imports via the Otero Pipeline into the South Platte basin average approximately 20,000 acre-feet per year, for use as municipal supply and/or exchange. It is believed (from the Project's Internet website) that the Otero Pipeline is gaged; also, the Homestake Tunnel, which is a major project feature, is gaged by the Bureau of Reclamation. Stream gages along the Arkansas River are located such that total diversions from the river may be derived if necessary, but this would be complicated by the need to allocate the total between the cities of Aurora and Colorado Springs. Only the Aurora portion goes into the South Platte. It is not currently known where the Otero Pipeline daylights in South Park. From topography and the general line of the tunnel on upgradient USGS maps, it is assumed that the pipeline daylights in the SASC2 local area or further downstream in the SPYC2 local area. That the importations contribute to Spinney Reservoir storage is well documented.

Several smaller diversions occur in the Beaver Creek/Beaver Ridge area of the basin near the town of Fairplay. Most of these appear to return to the Middle Fork of the South Platte within the SASC2 basin boundary. It is possible that small transfers over to the Tarryall Creek headwaters (TRKC2) do occur.

SPYC2 - Spinney Reservoir

Area: 83 mi^2
Irrigation: none
Upstream: SASC2
Downstream: EVNC2/SELC2

Description

This proposed local area basin is located in the central part of South Park, a major topographic feature between mountain ranges in central Colorado. Snowmelt forms the major component of the annual

runoff hydrograph. Buffalo Gulch is the main drainage for the local watershed, and trends northward to the South Platte. The basin is oriented in an elongated north-south direction, transected on the northern end by the South Platte. The local area consists of rolling hills and flatter grasslands and meadows, with irrigated pastures and hayfields occurring at lower elevations in a two- to three-mile wide band on each side of the river.

Spinney Reservoir (also known as Spinney Mountain Reservoir) was built by the City of Aurora, as part of the city's municipal water supply. At an elevation of 8,686 feet, the reservoir was completed in 1983 as an on-channel facility on the South Platte River. It has a nominal storage capacity of 54,000 acre-feet. Transmountain imports from the Frying Pan - Arkansas river basin are stored in Spinney Reservoir after delivery via the Otero Pipeline. These imports average about 20,000 acre-feet per year. In addition to local area runoff and river flows, ditch returns from SASC2 upstream (the Fritz, Harrington-Rickard, Harrington South, Western, and Central ditches) may form a small part of the reservoir storage, if diversions still occur on these ditches. The average annual release from Spinney Mountain, per Colorado's Hydrobase, is approximately 68 cfs; per the stream gage about 2 miles downstream the average annual release is about 86 cfs.

Inflows to Spinney Reservoir can be generally estimated from the upstream gage at SASC2. However, this would not account for the SPYC2 local area contributions or ditch returns, and it is not currently known if the Otero Pipeline imports are represented in the upstream gage. A lower elevation sub-basin parameter set from SASC2 could also be used as a starting point to calibrate the SPYC2 local area. Releases from Spinney Reservoir are gaged on the South Platte approximately 2 miles below the outlet. Daily flows are available at that site. The gage is located about halfway between Spinney Reservoir and the headwater of Elevenmile Reservoir (EVNC2) downstream.

Major Issues

The releases from Spinney Reservoir are probably not consistent with the more predictable patterns of flood control operations elsewhere. As such, municipal demands, water rights administration, and water exchanges are anticipated to complicate the reservoir modeling. The City of Aurora will have to be contacted to see if daily reservoir storage and/or elevation data are available. End-of-month (EOM) storage values are available from Colorado's Hydrobase.

EVNC2/SELC2 - Eleven Mile Reservoir/So. Platte River at Lake George

Area: 195 mi^2
Irrigation: none
Upstream: none
Downstream: Zone 3201, 3202, CHEC2

Description

These proposed segments are located the same point but have different names. This proposed local area is located in the eastern part of South Park, a relatively flat topographic feature dominated by open grasslands between the forested mountain ranges of central Colorado. Most of the local area occurs in the flatter grasslands at elevations of approximately 8,500 feet, but forested mountains occur in a narrow band around the eastern and southern perimeters of the watershed, rising to elevations on the order of 12,000 feet. Eleven Mile Reservoir is an on-channel storage facility on the South Platte River mainstem. The outlet of Eleven Mile Reservoir opens into a steep canyon (Eleven Mile Canyon) at the eastern edge of South Park, and the South Platte continues downstream through

forested mountains. The average annual release from Eleven Mile Reservoir is approximately 83 cfs per the stream gage, and about 52 cfs per Colorado's Hydrobase.

Eleven Mile Reservoir is owned and operated for municipal water supply by Denver Water. It has 97,800 acre-feet of storage. The Spinney Reservoir outlet gage is located on the South Platte about 2 miles upstream of Eleven Mile. Eleven Mile itself is gaged for pool elevation and release. The release gage is named "South Platte River near Lake George, Colorado". Although the village of Lake George (and the small reservoir for which it is named) is located approximately eight miles downstream, the actual flow gage location (as documented by latitude - longitude coordinates and USGS station information) is at the Eleven Mile Reservoir outlet. Proposed local area SELC2 (So. Platte River near Lake George) is not actively gaged at or near the town of Lake George as implied. Therefore, the next downstream flow gage on the South Platte is at the outlet of Cheesman Reservoir (CHEC2).

Major Issues

Inflows and releases from Eleven Mile Reservoir are complicated by water supply considerations. Under typical operations, the reservoir captures spring and summer runoff (dominantly snowmelt) to be released as municipal supply. The reservoir stores water in accordance with the administration of water rights, following the doctrine of prior appropriation. In addition to Denver Water, the cities of Aurora and Thornton (Denver suburbs) have been aggressively pursuing water rights acquisitions in South Park, and this may affect inflows and storage releases from Eleven Mile Reservoir.

CHEC2/DKRC2 - Cheesman Res./ So. Platte bl Cheesman Res.

Area: 101 mi^2
Irrigation: none
Upstream: none
Downstream: SPTC2

Description

This existing local area consists of rugged mountains, mostly vegetated with coniferous forests. Elevations range from approximately 6,550 feet to approximately 12,400 feet. The higher elevations occur in the northwestern part of the watershed, where numerous areas above treeline are present. (***See the description for Zone 3204, re: issues related to contributions from the high-elevation sub-basin and possible effects on modeling CHEC2.)*** Prior to the summer of 2002, a large area surrounding Cheesman Reservoir was unique in that it was virgin (uncut) coniferous forest. In June 2002 the Hayman fire burned almost all of the local area and much of Zone 3202 upstream, and this is expected to affect runoff and reservoir sedimentation in the locale. However, the watershed contributing to the reservoir is much larger than the local area, so hydrograph modifications may be minimal.

Cheesman Reservoir is owned and operated by Denver Water (DW) as a source of municipal supply. It has a storage capacity of approximately 79,000 acre-feet. Located on the South Platte channel, Cheesman Reservoir provides major storage and related data for the upper South Platte River. Essentially all water supplies flowing down the upper river are routed through Cheesman Reservoir. The stream gage (DKRC2) is located immediately below the reservoir outlet. The average annual release from Cheesman Reservoir is 174.2 cfs (126,000 acre-feet per year).DW collects reservoir pool elevation, release, and climatic data at the reservoir.

This segment includes zones 3201, 3202, and 3204 as described below.

Major Issues

Under typical operations, the reservoir captures spring and summer runoff (dominantly snowmelt) to be released as a supplemental municipal supply. The reservoir stores water in accordance with the administration of water rights, following the doctrine of prior appropriation. In recent years, the cities of Aurora and Thornton (Denver suburbs) have been aggressively pursuing water rights acquisitions in South Park, and this may affect inflows and storage releases from Cheesman Reservoir. The releases from Cheesman Reservoir are probably not consistent with the more predictable patterns of flood control operations elsewhere. As such, municipal demands, water rights administration, and water exchanges are anticipated to complicate the reservoir modeling.

ZONE 3201

Area: 187 mi^2
Irrigation: none
Upstream: none
Downstream: Zone 3202 / CHEC2

Description

This zone is one of two ungaged zones located between Eleven Mile Reservoir and Cheesman Reservoir. The watershed is steep and mountainous, and vegetation is mostly coniferous forest. The stream gage bearing the name of the proposed segment is actually located at the outlet to Eleven Mile Reservoir (EVNC2) upstream; thus there is no physical segment for SELC2. The South Platte in Zone 3201 flows downstream in Eleven Mile Canyon and Tappan Gulch. The village of Lake George, and the small reservoir for which it is named, occurs about 8 miles downstream of Eleven Mile Reservoir. A pumping station on the South Platte at Lake George is shown on USGS 7.5 minute topographic maps. On USGS 15-minute quads, an aqueduct trends up Twin Creek southeast of Lake George, passes through Florissant and Divide, and into North Catamount Reservoir northwest of the town of Manitou Springs. Currently, no specific diversion data has been identified for this structure.

Major Issues

There are no known available time series for this area. Apparently a diversion exists from the South Platte at Lake George over to North Catamount Reservoir (City of Colorado Springs). Further investigation to verify and quantify this diversion is needed.

ZONE 3202

Area: 130 mi^2
Irrigation: 291 ac
Upstream: SELC2/3201/ALLC2
Downstream: CHEC2

Description

This zone is one of two ungaged zones located between Eleven Mile Reservoir and Cheesman Reservoir. The South Platte in this basin flows in a steep canyon approximately four miles long before entering Cheesman Reservoir. The watershed is steep and mountainous, and vegetation is mostly coniferous forest. In June 2002 the Hayman fire burned much of this area. Tarryall Creek,

which drains the vast majority of the local area, joins the South Platte in the far eastern part of this watershed. Upstream on Tarryall Creek is Segment ALLC2, which is a proposed local area that drains through Tarryall Reservoir.

Major Issues

There are no known available time series for this zone

ZONE 3204 - Lost Creek Drainage

Area: 43 mi^2
Irrigation: none
Upstream: none
Downstream: CHEC2

Description

This is a mountainous high-elevation zone to the northwest of Cheesman Reservoir. Elevations range from 9,300 to 12,300 feet, with a mean of 10,700 feet. Vegetation consists of coniferous forest, isolated park-like areas of grass and shrubs, and alpine tundra. In June 2002, the Hayman fire burned some of the watershed.

Upon close inspection of USGS 7.5 minute topographic maps, it appears that the Lost Creek basin (Zone 3204) is enclosed, and does not drain into CHEC2 via Goose Creek (the western arm of Cheesman Reservoir) as depicted on the basin topology diagram. A number of isolated topographic "bowls" are shown along the creek on the USGS maps. Going simply by the USGS maps, a narrow divide between Zone 3204 and CHEC2 apparently is located further into the CHEC2 watershed than previously identified. If actually a hydrologic barrier, this would cut roughly 20 square miles of the westernmost high-elevation drainage area (up to 12,400 feet) from the CHEC2 basin.

Further checking on the Internet indicates that Lost Creek commonly travels under massive rock piles (large enough to influence contours on topographic maps?) and then re-appears. On this basis, it is possible that flow from Zone 3204 re-appears as streamflow in Goose Creek, and ultimately contributes to Cheesman Reservoir. On a larger scale, the general trend of the topography seems to support this.

Major Issues

There are no stream gages for the watershed. It is not clear if this zone is hydrologically isolated or actually contributes surface flows to the South Platte.

SPTC2 - So. Platte R. at South Platte

Area: 91 mi^2
Irrigation: none
Upstream: none
Downstream: WATC2

Description

This existing local area is located just below the confluence of the South Platte mainstem (as flows from Cheesman Reservoir) and the North Fork of the South Platte. It consists of forested mountains

and foothills at elevations ranging from about 6,100 to 10, 350 feet, with a mean elevation of about 7,400 feet. In addition to basin runoff and releases from Cheesman Reservoir, the stream gage receives transmountain imports down the North Fork via the Roberts Tunnel. The tunnel was completed in 1962. The 1990-1999 average annual importation through the tunnel was approximately 69,000 acre-feet (95 cfs). The average annual streamflow at the SPTC2 gage (below the confluence) is approximately 400 cfs (290,000 acre-feet per year).

SPTC2 has daily flow measurements available through September, 2002. Data at a shorter time step may also be available. Diversion records and releases from the Roberts Tunnel and Cheesman Reservoir are also available at a daily time step, and possibly a shorter interval. In addition, daily data are available through September 1982 for the North Fork of the South Platte immediately upstream of the SPTC2 gage. This may be of further use in deriving a general idea of native flows in Zone 3209 or other segments upstream. Average measured annual flows for the North Fork from 1963 through 1982 were 206 cfs (150,000 acre-feet).

This segment includes zones 3205, 3206, and 3209 as described below.

Major Issues

Flows at the gage are highly affected by water supply releases at Cheesman Reservoir (CHEC2/DKRC2), as well as by importations from the Roberts Tunnel (RBTC2). Both these structures are gaged, the latter by the Bureau of Reclamation. Zones 3205, 3206, and 3209 (all currently ungaged) contribute to streamflows at this site.

Denver Water estimated annual streamflow depletions (chiefly from irrigation and municipal water supply) at this station for the period 1916 through 1982. The average annual depletion (reduction from derived native flows) was approximately 24,000 acre-feet. The maximum annual depletion was about 190,000 acre-feet, and the "minimum" was actually a contribution (release from storage) of about 102,000 acre-feet. For the period 1950 through 1980, Hydrosphere derived a mean normal-year streamflow depletion of about 6,200 acre-feet for the station, a mean dry-year contribution (release from storage) of about 46,000 acre-feet, and a mean wet-year depletion of approximately 49,000 acre-feet. For the same period, a derived average depletion using DW values would be about 11,200 acre-feet.

ZONE 3209

Area: 170 mi^2
Irrigation: 151 ac
Upstream: NFSC2
Downstream: SPTC2

Description

This zone is an ungaged area located between SPTC2 and NFSC2. It consists of forested mountains and some alpine areas, at elevations ranging between about 6,100 to 12,200 feet. The North Fork of the South Platte River is the major drainage.

Major Issues

Daily data are available through September 1982 for the North Fork of the South Platte immediately upstream of the SPTC2 gage. This may be of use in deriving a general idea of native flows in Zone 3209 or other segments upstream. The average annual flow for the North Fork from 1963 through

1982 was 206 cfs (150,000 acre-feet). The Roberts Tunnel, which imports to the North Fork, was opened in 1962.

ZONE 3205 - Wigwam Creek drainage

Area: 34 mi^2
Irrigation: none
Upstream: none
Downstream: SPTCC2

Description

This zone is one of two ungaged zones located between Cheesman Reservoir and the stream gage on the South Platte at the village of South Platte (SPTC2). It consists of forested mountains at elevations ranging between about 6,500 to 11,500 feet. Wigwam Creek is the major drainage.

Major Issues

There are no known data sets for this area. Four diversions totaling 1.4 cfs have decreed rights on Wigwam Creek.

ZONE 3206 - Horse Creek drainage

Area: 223 mi^2
Irrigation: none
Upstream: none
Downstream: SPTC2

Description

This zone is one of two ungaged zones located between Cheesman Reservoir and the stream gage on the South Platte at the village of South Platte (SPTC2). It consists of forested mountains at elevations ranging between about 6,500 to 10,500 feet. Fourmile and Horse creeks are the major drainages.

Major Issues

There are no known data sets for this area. Four diversions totaling 13.8 acre-feet per year have decreed rights on Fourmile Creek, and one diversion totaling 5 acre-feet per year is decreed on Horse Creek.

WATC2 - So. Platte River at Waterton

Area: 45 mi^2
Irrigation: none
Upstream: SPTC2
Downstream: CFDC2, and (via diversions) APRDIV, EDGC2

Description

This existing local area consists of foothills and steep canyons vegetated with brush and coniferous forest. The basin elevation ranges from about 5,500 feet to 8,700 feet, with an average of about 7,000 feet. The South Platte mainstem flows into Waterton Canyon below its confluence with the North

Fork at SPTC2. At its mouth, the canyon opens dramatically into the western portion of the Denver metropolitan area. Chatfield Lake and other diversions are downstream.

Strontia Springs Reservoir is located on the South Platte channel in the central part of Waterton Canyon, at an elevation of 6,200 feet. It is operated by Denver Water (DW). The reservoir was completed in 1986, and has a storage capacity of 7,700 acre-feet. The City of Aurora owns 700 acre-feet of storage in Strontia Springs; the rest belongs to DW. Inflow, outflow, pool elevation, and storage are monitored at Strontia Springs Reservoir by DW, and mean daily values are readily available.

Aurora diverts from the reservoir onto the plains through A-R Tunnel Nos. 1 and 2. Aurora-Rampart Reservoir (capacity 1,300 acre-feet) is located outside the canyon, and diversions are routed from there into the Foothills Treatment Plant, as well as through an aqueduct that appears to terminate in the immediate vicinity of Cherry Creek Reservoir (EDGC2). Diversion records for the Aurora Intake extend from 1967 (prior to reservoir construction) and indicate an average diversion rate of approximately 31,000 acre-feet per year (about 50 cfs).

Additional diversions occur from the river downstream of Strontia Springs Reservoir and just upstream of the canyon mouth. The major diversions include:

- Denver Foothills Pipeline - since 1983, this has averaged about 140,000 acre-feet per year (about 200 cfs). Either this pipeline or Conduit 20 below diverts water to Marston Reservoir, which drains to Bear Creek (SHRC2).

- Denver Conduit 20 - since 1950, this has averaged about 80,000 acre-feet per year (about 130 cfs)

- Denver Highline Canal - since 1950, this has averaged about 23,000 acre-feet per year (about 120 cfs)

- Platte Canyon Ditch - since 1955, this has averaged about 1,200 acre-feet per year (about 18 cfs). In many years water is not diverted at this structure.

As mentioned above, DW monitors Strontia Springs Reservoir. Historical monthly diversion data are available from Colorado's Hydrobase and DW for the major diversions identified above. Since these facilities are operated by DW and the City of Aurora, it may be possible to obtain shorter-interval data. However, the availability of real-time data for the diversions is currently unknown. The U.S. Army Corps of Engineers monitors Chatfield Reservoir, and those data are available at a daily time step or less. Such data may be of some benefit to forecasting this upstream area during high-water events, if the Waterton gage is submerged. The Waterton gage on the South Platte has data through December 2002 available from Hydrobase.

Major Issues

The existing local area contains a complex water storage and withdrawal infrastructure that has major effects on the stream gage readings at Waterton. In addition, USGS maps indicate that the gage location is within the high-water inundation zone of Chatfield Reservoir. These factors will complicate operational forecasting of normal and emergency events, as well as ESP efforts.

CFDC2 - Chatfield Reservoir

Area: 117 mi^2
Irrigation: 151 ac
Upstream: WATC2, LOVC2
Downstream: ENWC2

Description

This existing local area consists of foothills, plains, and urban areas with a variety of vegetation and land surface types. Elevations range from about 5,400 to 8,700 feet, with a mean of about 6,330 feet. The major basin feature is Chatfield Reservoir, which is a U.S. Army Corps of Engineers (USACE) flood control facility on the South Platte River channel. The reservoir is also used extensively for recreation. Construction of Chatfield Reservoir began in 1967 and was completed in 1975. The multi-purpose pool has an area of approximately 1,480 acres and storage of 27,046 acre-feet. The total flood storage capacity is 355,000 acre-feet, at a pool extent of about 4,800 acres. The normal outlet consists of a 7-foot diameter conduit with a rated capacity of 2,000 cfs. The overflow spillway is an ungated chute with a rated capacity of 188,000 cfs at maximum pool.

USACE monitors hourly pool elevation at Chatfield Reservoir. Colorado's Department of Water Resources maintains daily outflow records. The outflow period of record extends from late July 1986. Climatic data are available for the region and may be collected at the reservoir.

The City Ditch (Denver Water) diverts from Chatfield Dam and runs along the South Platte though Denver. Over 53 years of record, average annual diversions in the ditch are about 8,500 acre-feet; however, in the past ten years or so, diversions have increased to between 10,000 and 20,000 acre-feet per year. The unconsumed portions of these diversions probably return to the South Platte through the urban drainage system in Segments DNVC2 and HNDC2. Additional verification with DW would need to be done to gain further data and understanding of the City Ditch system and its effects on Chatfield Reservoir (CFDC2) and flows in DNVC2 and HNDC2. The timing, diversion rates, and return flows from the City Ditch system may have a significant effect of South Platte River flows below Chatfield Reservoir and on the parameterization of existing segments DNVC2 and HNDC2.

Major Issues

The effects of upstream river regulation are particularly pronounced at Chatfield Reservoir and downstream. Chatfield Reservoir diversion records indicate that an annual average of approximately 22,000 acre-feet pass through the structure itself. In a normal year, estimates from Hydrosphere indicate that native flows at Chatfield average about 286,500 acre-feet, with regulated flows being about 134,300 acre-feet. In dry years, the estimated native flows at Chatfield average about 117,200 acre-feet, with regulated flows averaging about 49,400 acre-feet. In wet years, the estimated native flows at Chatfield average about 649,000 acre-feet, with regulated flows averaging about 392,500 acre-feet. Under a variety of conditions therefore, it is typical for large diversions to be made from the river above the reservoir (see particularly WATC2). Additional diversions from the reservoir are made by Denver Water for municipal supplies (see CCDIV).

ENWC2 - So. Platte River at Englewood, CO

Area: 76 mi^2
Irrigation: 5 ac
Upstream: CFDC2

Downstream: DNVC2

Description

According to the topology diagram for the existing forecast system, this segment is actually represented by the USGS gage "South Platte River at Union Ave. at Englewood" (06710245, 06710247). The gage representing the "South Platte River at Englewood" (06711565) is located approximately 2 miles farther downstream, and measures contributions from the Bear Creek system, Marston Lake, and Little Dry Creek as well as the South Platte. The difference in watershed area is approximately 344 square miles

This is an existing local area segment that consists of urban developments interspersed with open grasslands. Elevations range from about 5,000 to 7,900 feet, with an average of 5,750 feet. Small reservoirs (e.g., Johnson, McLellan, Bowles), gravel pits, and urban drainage features influence the river flows between Chatfield Reservoir and the segment gage. A number of wells may also exist in the basin and may influence groundwater recessions. The ten-year average annual flow is approximately 94 cfs (about 68,000 acre-feet per year). A daily flow time series is available at the segment's USGS gage on the South Platte. Overlapping time series for Chatfield Reservoir and the downstream station (see table footnote above) are also available.

Major Issues

None are currently known. Some returns from Marston Lake (owned by Denver Water) and a filtration plant near the mouth of Little Dry Creek may actually re-enter the South Platte River above the streamgage via pipeline.

DNVC2 - South Platte River at Denver

Area: 112 mi^2
Irrigation: none
Upstream: SHRC2, EDGC2, ENWC2, CCDIV, APRDIV (diversion returns)
Downstream: HNDC2, diversions

Description

This is an existing local area segment in the Denver/Lakewood urban area. Dense industrial, commercial, and residential developments occur throughout the watershed. Within the local area, major tributaries to the South Platte River include Cherry Creek and Little Dry Creek from the southeast, and Lakewood Gulch and Sanderson Gulch from the west. Elevations range from about 5,160 feet to 6,680 feet, with a mean local area elevation of 5,490 feet. A number of small reservoirs (e.g. Sloans Lake, Englewood Dam) occur on local area drainages. Gravel pits also occur along the river channel.

For the period 1980 through 2002, the mean annual flow at DNVC2 was 394 cfs (285,600 acre-feet per year). The range in mean annual flows, which may give some indication of the influence of diversions and returns, was from 109 cfs (79,000 acre-feet per year) in the drought year 2002, to 965 cfs (700,000 acre-feet per year) in 1984.

Major diversion structures traversing the local area include the City Ditch and the Denver Highline Canal (see CCDIV, WATC2). Over 53 years of record, average annual diversions in City Ditch are about 8,500 acre-feet. However, in the past ten years or so, diversions have increased to between 10,000 and 20,000 acre-feet per year. Since 1950, the Denver Highline Canal diversion has averaged

about 23,000 acre-feet per year (about 120 cfs), and this average is reasonably consistent with recent years.

The USGS maintains the stream gage on the South Platte at Denver. Daily data are available. Real-time data are available for the South Platte River at 64th Avenue in Commerce City, about halfway between DNVC2 and HNDC2. Denver Water and the State Division of Water Resources would need to be contacted further to determine the availability and types of additional data.

Major Issues

Diversions, consumptive use, and return flows have considerable effect on the gaging data. Small reservoirs, gravel pits, and well pumping also affect the hydrograph. The availability of adequate data for the diversions and return flows is a limiting factor in deriving native flow estimates, calibration, and performing forecast system functions.

HNDC2 - South Platte River at Henderson

Area: 146 mi^2
Irrigation: 144 ac
Upstream: DNVC2, SACC2, other diversions and returns
Downstream: KERC2, DEHDIV (diversions)

Description

This is an existing local area segment on the South Platte River at the northern end of the Denver metropolitan area. The basin consists mainly of rolling hills and grasslands dissected by tributaries of the South Platte. The major tributaries include Sand Creek (SACC2) and Clear Creek (DBRC2). Elevations range from about 5,000 feet to 5,950 feet, with an average basin elevation of about 5,300 feet. Much of the basin is within the City of Denver, and the cities of Commerce City and Thornton are expanding into surrounding farmlands within the watershed. From 1980 through 2002, the mean annual flow on the South Platte at the Henderson gage was about 596 cfs (432,000 acre-feet per year). The lowest annual average was in 2002, with 242 cfs (175,400 acre-feet per year), and the highest annual average was 1,379 cfs (about 1,000,000 acre-feet per year) in 1983.

A number of gravel pits and wells are located in the South Platte River floodplain within this local area. In addition, several major canals and ditches divert water from the river between the gage at Denver (DNVC2) and Henderson (HNDC2). These are used for agricultural purposes, including providing storage at Barr Lake (33,000 acre-feet), Horse Creek Reservoir (17,000 acre-feet), Prospect Reservoir, and Milton Reservoir. These are all off-channel reservoirs.

Major canals and ditches in the system include the Fulton Ditch, the Burlington Ditch (which bifurcates into the Little Burlington Ditch and the O'Brian Canal, which in turn feeds Barr Lake), the Brighton Ditch (a lateral of the O'Brian Canal), the Neres Canal, Speer Canal, and the Denver Hudson Canal (all three of which commence at Barr Lake). From 1950 through 2002, the Burlington Ditch diverted an average of about 80,600 acre-feet per year from the river above Henderson. Over the same period, the Fulton Ditch diverted an average of about 28,000 acre-feet per year.

The Burlington Ditch and the Fulton Ditch may have daily data available. FRICO (Farmers Reservoir and Irrigation Company) may be able to provide some data and parametric information for Barr Lake. The USGS maintains the gage on the South Platte at Henderson, and daily data are

available for the location. Real-time data are available for the South Platte at 64th Avenue in Commerce City, above Clear Creek and about halfway between DNVC2 and HNDC2.

Major Issues

Significant diversions occur from the river channel above the stream gage, and municipal returns may enter the channel as it passes through the basin. In addition, gravel pits and well pumpage probably influence ground water contributions from the alluvial aquifer. Out-of-basin transfers occur from the Fulton and Burlington Ditch. Portions of these return to the river in the Brighton - Fort Lupton area, but obviously consumptive use removes some of the volume. Other secondary diversions are routed further east into Horse Creek and Prospect reservoirs. These may be lost to consumptive uses or infiltration in the sand hills without returning to the South Platte. The Highline Canal (see WATC2) terminates in the eastern area of the watershed. Diversions are probably lost to seepage and consumptive uses along its length, including municipal uses in the Montbello area of Aurora. The canal terminates at Derby Lake and Ladora Lake east of Commerce City.

Lower South Platte

Following is a list of tributaries and segments in the Lower South Platte basin.

Poudre River: EHNC2, SEAC2, POUC2, GRPC2
Big Thompson River: BKHC2, DKKC2, ESSC2, LSLC2
St. Vrain Creek: LNSC2
Boulder Creek: OROC2
Lonetree Creek: LNEC2
Lodgepole Creek: BSHN1, RALN1
Lower South Platte River: KERC2, WNAC2, BZNC2, JULC2, RSON1, PXTN1, SPSN1

Poudre River

EHNC2 – Cache La Poudre River below Elkhorn Creek

Area: 409.1 mi^2
Irrigation: none
Upstream: none
Downstream: SEAC2

Description

This is a headwater segment encompassing the main run-off producing areas of the Cache La Poudre River. The natural hydrograph is typical for snow melt driven river flows, with low winter flows, increased spring and summer flows usually peaking in June, and then attenuating flows in the fall. Winter baseflows (November – March) are around 45 cfs, while average daily flows in June are over 1600 cfs. Several transbasin ditches import water from the Colorado and North Platte river basins. Municipal water providers and several irrigation companies own and operate high mountain reservoirs located in this segment.

Streamgage POR: not identified
Annual Regulated Flows : 262,000 acre-feet
Annual Naturalized Flows: 221,500 acre-feet

Note: Regulated and Naturalized flows based upon previous hydrologic investigation using 1950-2001 hydrology.

Major Issues

Approximately 42,000 acre-feet are imported into the basin each year. Imported water is a function of hydrology, water rights, and interstate Compacts in the contributing basins and flows can vary widely from year to year. The two largest structures, Grand River Ditch and Laramie Poudre Tunnel, have been rehabilitated due to massive structural failures in the last three years. Sometimes the imported water is placed into storage, while other times it may be delivered directly to the lower basin demands, depending upon the type of water year and other considerations.

The mountain reservoirs have a total active storage capacity of 32,000 acre-feet. Under typical operations, the reservoirs capture spring runoff to be released in the late summer as a supplemental supply for both agricultural and municipal uses. The reservoirs store water in accordance with the administration of water rights under the Doctrine of Prior Appropriation. In an average year, the reservoirs are not allowed to store water (with the exception of imports and exchanges) after the lower basin direct water rights begin calling water in mid-June. In a dry year, such as 2004, the senior direct decrees placed a call in the first week in April, thus eliminating the opportunity for a storage run.

SEAC2 – Seaman Reservoir

Area: 554 mi^2
Irrigation: 1,240 acres
Upstream: none
Downstream: POUC2

Description:

This segment covers the North Fork of the Cache La Poudre River. Runoff on the North Fork is much less than the mainstem due to its lower elevation and reduced snowpack. Monthly average flows range from only 10 cfs in the winter to 175 cfs in May. The main channel contains three reservoirs and a major diversion structure. Several small diversions and holding ponds are located on the tributaries.

Streamgage POR: not identified
Annual Regulated Flows : 28,600 acre-feet
Annual Naturalized Flows: 61,600 acre-feet
Note: Regulated and Naturalized flows based upon previous hydrologic investigation using 1950-2001 hydrology.

Major Issues

The three on-channel reservoirs have a total active capacity of 14,300 acre-feet. Two of the reservoir are owned and operated by irrigation companies, and follow a fairly constant pattern of storage and release. Seaman reservoir is a source of water for municipal use. It is used to store native flows as well as excess seasonal supplies from the Colorado-Big Thompson (CBT) and Windy Gap projects. Water is moved up-river through a series of exchanges and trades. Proposed reservoir enlargements may increase storage capacity on the North Fork by approximately 60,000 acre-feet. These projects are scheduled to begin the NEPA permitting phase in 2004.

The North Poudre Canal, just downstream of Halligan Reservoir, will divert over 50% of the river's annual flow in some years. Diversions include native river flows, upstream reservoir releases, and water exchanged from downstream reservoirs and water rights.

POUC2 – Cache La Poudre River at Fort Collins

Area: 240 mi^2
Irrigation: 12,913 acres
Upstream: EHNC2, SEAC2
Downstream: GRPC2

Description

The drainage area in this segment produces much less natural inflow than upstream segments, but it does contain Horsetooth Reservoir, a primary feature of the USBR Colorado-Big Thompson system, importing an average of about 100,000 acre-feet into the basin from the Colorado River basin. The largest impact upon river flows is diversions for irrigation and storage. Irrigated acreage in the lower Poudre basin is estimated at 200,000 acres with approximately 150,000 acre-feet of active storage in off-system, plains reservoirs.

Streamgage POR: 1975-present
Annual Regulated Flows : 74,500 acre-feet
Annual Naturalized Flows: 310,000 acre-feet
Note: Regulated and naturalized flows based upon previous hydrologic investigation using 1950-2001 hydrology.

Major Issues

This is a complex and heavily regulated river segment. The effects of diversions, reservoir releases, and to a lesser extent, return flows, result in a completely altered flow regime. Annual diversions for irrigation use amount to 285,000 acre-feet in an average year. Diversions in the spring generally are placed into storage to be used as a late season supplemental source for irrigation. A large portion of late season diversions can consist of CBT water released from Horsetooth Reservoir, as well as reservoir releases from mountain storage. Water rights administration in this river reach is very complicated and highly enforced. State water commissioners check diversion rates at headgate structures on a daily basis during the irrigation season for compliance with the administrative call. Of the several hundred water rights in the basin, only a handful of the most senior rights are able to divert water during low flow periods. It is not uncommon for the entire river flow to be diverted for brief periods in late July and August. Groundwater pumping from shallow tributary aquifers is estimated to be 40,000 acre-feet per year.

GRPC2 – Cache La Poudre River at Greeley

Area: 688 mi^2
Irrigation: 137,449 acres
Upstream: POUC2
Downstream: KERC2

Description

This river reach is highly regulated by both physical structures and water rights administration. Local natural inflow is limited to runoff from rainfall events and is almost insignificant compared to upstream flows from snowmelt. But under current effects of streamflow regulation, this is a gaining

river segment due to large surface and groundwater inflows as a result of inefficient irrigation practices.

Streamgage POR: 1914-present
Annual Regulated Flows : 103,000 acre-feet
Annual Naturalized Flows: n/a

Major Issues

Irrigation diversions average 110,000 acre-feet per year while return flows from agricultural use (120,000) and municipal use (18,000) results in a net gain of almost 30,000 acre-feet per year. The combination of diversions and returns results in a regulated hydrograph that is much smaller during the high flow period in the spring and larger in the late fall and winter, as compared to a natural hydrograph. Groundwater pumping from shallow tributary aquifers is estimated to be 90,000 acre-feet per year.

Big Thompson River

BKHC2 – Buckhorn Creek near Masonville

Area: 138 mi^2
Irrigation: 1,293 acres
Upstream: none
Downstream: LSLC2

Description

The drainage area in this segment contributes a relatively small amount of flows to the Big Thompson River, although it is prone to flash floods and short but intense snowmelt-runoff periods. Streamflow regulation is limited to small stockponds and some irrigated pastures.

Streamgage POR: 1947-1955
Annual Regulated Flows: 21,000
Annual Naturalized Flows: 15,000
Note: Naturalized flow estimate based upon previous hydrologic investigation using 1970-2001 hydrology. Regulated flows are based upon historic gage.

Major Issues

None

DKKC2 – North Fork Big Thompson River at Drake

Area: 84 mi^2
Irrigation: none
Upstream: none
Downstream: LSLC2

Description

The headwater segment has snow-melt driven river flows. Streamflow regulation in this segment is negligible. Much of this drainage area is in Rocky Mountain National Park and has little or no streamflow regulation.

Streamgage POR: 1947-present
Annual Regulated Flows: 25,250
Annual Naturalized Flows: 25,250

Major Issues

None

ESSC2 – Lake Estes

Area: 161 mi^2
Irrigation: none
Upstream: none
Downstream: LSLC2

Description

This headwater segment is highly regulated. Lake Estes is a receiving point for CBT transbasin imports via the Alva B. Adams Tunnel. The capacity of the tunnel is 500 cfs and the annual imports average 230,000 acre-feet. CBT water has two primary functions. The first is to generate power as it descends from the mountains to plains. Secondly, it is a supplemental source of supply for irrigators and municipal water providers within the Northern Colorado Water Conservancy District (NCWCD). The district covers portions of the Poudre River, Big Thompson River, St. Vrain Creek, Boulder Creek, and lower South Platte River basins. Although all of the CBT water enters the Big Thompson headwater region, project water can be moved both north and south by means of canals, siphons, and pumps and only a fraction will actually pass through Lake Estes and the La Salle gage lower in the Big Thompson basin.

Streamgage POR: not identified
Annual Regulated Flows: 67,000
Annual Naturalized Flows: 100,000
Notes: Regulated and naturalized flows based upon information provided by NCWCD.

Major Issues

CBT project water enters Lake Estes after first passing through Mary's Lake Power Plant. CBT water entering Lake Estes is usually routed through the Olympus Tunnel and Pole Hill Power Plant, eventually reaching a bifurcation structure from which water can be: a) pumped out of the basin into Carter Lake for eventual deliveries to Boulder Creek or the Southern Supply Canal, or b) diverted back towards the Big Thompson river and either diverted over the Big Thompson river through a siphon and delivered to Horsetooth Reservoir, or run through a power plant and discharged back into the Big Thompson river. During high runoff periods, native flows will also be diverted through the Olympus Tunnel and dumped back into the Big Thompson River.

The year-to-year operations and delivery patterns of CBT water are highly variable. There are 310,000 CBT units owned by district constituents, currently with about 60% owned by municipal water providers and 40% owned by irrigators. The total volume of water imported from the Colorado basin is dependent upon the annual quota set by NCWCD. The quota is set in April of each year and historically has varied from 100% to 40%. Thus, a 100% quota results in a delivery of 310,000 acre-feet, while a quota of 40% would result in a delivery of 124,000 acre-feet. CBT shares can be bought and sold, as well as rented and leased. Therefore, CBT units are highly mobile throughout the basin. The current trend has resulted in a significant shift of CBT water from the north (Poudre and Big Thompson basins) to the south (Boulder Creek and lower South Platte), as project water migrates

towards the locations of rapid population growth. IT MAY BE RECOMMENDED THAT THE DELIVERY-STORAGE-DISTRIBUTION COMPONENT OF OPERATIONS OF THE C-BT SYSTEM BE IGNORED AND ONLY THE POINT OF INTRODUCTION INTO THE NATURAL STREAMS BE CONSIDERED.

LSLC2 – Big Thompson River at La Salle

Area: 447 mi^2
Irrigation: 71,494 acres
Upstream: BKHC2, DKKC2, ESSC2
Downstream: KERC2

Description

This segment receives flows from the three upstream headwater segments and the runoff from the Little Thompson river basin. Besides the effects of upstream regulation, there is significant regulation occurring within this segment due to storage and irrigation.

Streamgage POR: 1927-present
Annual Regulated Flows: 76,000
Annual Naturalized Flows: 170,000
Notes: Regulated and naturalized flows based upon previous hydrologic investigation using 1970-2001 hydrology.

Major Issues

Although water rights tend to dictate the allocation of native flows, the introduction of CBT water into the basin is very much dependent upon operations in downstream segments. Historically, CBT water was routed through the La Salle gage as it flowed toward irrigation demands on the lower South Platte. This practice is slowly disappearing as more and more project water is routed through Horsetooth Reservoir and Carter Reservoir in route to municipal water providers.

Within the segment, approximately 185,000 acre-feet of both native and CBT water is diverted annually at the 20+ major diversion structures. Most of the diversions are for 72,000 acres of irrigated farmland. Active storage in the basin is close to 116,000 acre-feet, not including the CBT project storage reservoirs. Due to geologic characteristics, there is very little groundwater pumping in this segment.

St. Vrain Creek

LNSC2 – St. Vrain Creek at Lyons

Area: 217 mi^2
Irrigation: 118 acres
Upstream: none
Downstream: KERC2

Description

This snowmelt driven headwater segment has some regulation due to diversions and storage reservoirs. The majority of streamflow regulations on St. Vrain Creek occur below Lyons.

Streamgage POR: 1900-present
Annual Regulated Flows: 93,000
Annual Naturalized Flows: 120,000
Notes: Regulated and naturalized flows based upon previous hydrologic investigation using 1965-1999 hydrology.

Major Issues

There are approximately 20,000 acre-feet of active storage capacity and eight diversion structures in this segment, serving both municipal and irrigation uses. The major municipal water user is the City of Longmont and owns two pipelines that divert water off of the river.

Boulder Creek

OROC2 – Middle Boulder Creek at Ordell

Area: 102 mi^2
Irrigation: none
Upstream: none
Downstream: KERC2

Description

Besides a few high mountain storage reservoirs and limited diversions, there is little regulation in this high mountain headwater region. Runoff from this segment is a primary source of water supply for downstream municipalities.

Streamgage POR: 1906-present
Annual Regulated Flows: 60,000
Annual Naturalized Flows: 72,750
Notes: Naturalized flows based upon information provided by Boulder Public Works Department.

Major Issues

Barker Reservoir (11,200 acre-feet capacity) and the Boulder City Aqueduct are the main regulation features in this segment. Barker reservoir releases are used for power generation and are routed to downstream municipal or irrigation uses. The aqueduct has a capacity of 70 cfs and diverts around 700 acre-feet per month consistently throughout the year.

Lonetree Creek

LNEC2 – Lone Tree Creek near Greeley

Area: 581 mi^2
Irrigation: 43,973 acres
Upstream: none
Downstream: KERC2

Description

The drainage area in this segment is at a lower elevation than other headwater regions. In a natural state, this would be an ephemeral stream with flows primarily in the spring and during summer

thunderstorms. But due to the effects of return flows from irrigation, this creek tends to run the entire year.

Streamgage POR: 1993-present; intermittent
Annual Regulated Flows: 7,000
Annual Naturalized Flows: 5,000

Major Issues

Although there are a few small stock ponds along this creek, the main regulation issue is the accretion of flow due to runoff from local irrigation districts. Baseflows, resulting from irrigation runoff, appear to be on the order of 1 to 4 cfs throughout the year.

Lodgepole Creek

BSHN1 – Lodgepole Creek at Bushnell

Area: 1,125 mi^2
Irrigation: 3,262 acres
Upstream: none
Downstream: RALN1

Description

Average monthly flows in this headwater segment range from than less than 1 cfs to 70 cfs at Bushnell. Diversions from Lodgepole Creek in Wyoming are approximately 10,000 acre-feet per year. Staff at the Nebraska Department of Natural Resources indicated that in Nebraska, the diversion structures on the creek are no longer active.

Streamgage POR: 1934-1991
Annual Regulated Flows: 7,100
Estimated Naturalized Flows: 21,000

Major Issues

None

RALN1 – Lodgepole Creek at Ralton

Area: 514 mi^2
Irrigation: 152 acres
Upstream: BSHN1
Downstream: JULC2

Description

Between Bushnell and Ralton, there is some streamflow regulation. Oliver Reservoir has a capacity of 4,690 acre-feet. There are some diversions from the creek, but no diversion records have been located.

Streamgage POR: 1951-1973, recently reactivated by Nebraska DNR
Annual Regulated Flows: 6,300

Estimated Naturalized Flows: n/a

Major Issues
None

Lower South Platte River

KERC2 – South Platte River at Kersey

Area: 1,304 mi^2
Irrigation: 247,872 acres
Upstream: GRPC2, LSLC2, LNSC2, OROC2, LNEC2, HNDC2
Downstream: WNAC2

Description
Several upstream segments flow into KERC2. The flows in this reach are extremely altered due to the effects of physical and administrative regulation both upstream and within the segment. Most of the flows are municipal and irrigation return flows. Over 50% of the naturalized flows are depleted prior to exiting this segment. From this segment to the confluence with the North Platte groundwater pumping becomes prevalent and has a large effect on streamflows. Estimates of groundwater pumping in the South Platte alluvium range from 300,000 acre-feet to over 600,000 acre-feet (groundwater pumping has not been metered historically). The groundwater is hydrologically connected to the surface flows, and therefore administered in Colorado under the Prior Appropriation Doctrine and the amended rules and regulations governing the diversion and use of tributary groundwater in the South Platte river basin. Due to current drought conditions, over 1,000 high-capacity wells are expected to be shut down. Much of the irrigation occurs in the lower St.Vrain and Boulder Creek drainages.

Currently, there are several projects being proposed throughout the metropolitan area that would effectively capture and reuse existing unused municipal return flows to extinction. This would result in decreased flows at Kersey.

Streamgage POR: 1902-present
Annual Regulated Flows: 623,000
Annual Naturalized Flows: 1,371,000
Notes: Regulated and naturalized flows based upon previous hydrologic investigation using 1950-1980 hydrology.

Major Issues (organized by upstream tributary)
Cache La Poudre – Presently, the only regulation effects occurring between GRPC2 and KERC2 is the flow accretion due to return flows. A proposed storage, pump-back facility could potentially divert around 30,000 acre-feet from the lower Poudre River for re-use in the Poudre basin.

St. Vrain – Between LNSC2 and KERC2, there are approximately 37 irrigation systems diverting an average of 100,000 acre-feet (40,000 acre-feet during a low flow year) and approximately 16,000 acre-feet of storage. Conditional storage rights for proposed reservoir enlargements total over 150,000 acre-feet.

Boulder Creek – The drainage between OROC2 and KERC2 contains several tributaries (South Boulder Creek, North Boulder Creek, and Left Hand Creek) before it merges with the St. Vrain Creek. Annual regulated flow volume at the mouth of Boulder Creek is 48,600 acre-feet, while the naturalized flow is estimated at over 140,000 acre-feet. There are numerous regulation activities. Water is diverted for municipal, industrial, and irrigation uses. Municipal water users include the cities of Denver, Boulder, Longmont, Louisville, Lafayette, and several regional water providers. Denver imports about 12,000 acre-feet per year through the Moffat Tunnel, but this water is delivered to Denver Water and does not pass through the Kersey gage.

Lonetree Creek - none

South Platte – Only a small portion of Denver municipal return flows occur below the Henderson gage. There are several ditches delivering water to irrigated lands.

WNAC2 – South Platte at Weldona

Area: 1,493 mi^2
Irrigation: 146,340 acres
Upstream: KERC2, ZONE 3216, ZONE 3279
Downstream: WNAC2

Description

This mainstem segment runs through a heavily irrigated area. Large volumes of surface diversions, groundwater pumping, and return flows occur in this river reach. Zone 3216, Crow Creek drainage, originates in Wyoming. The South Platte River Basin in Wyoming contains Cheyenne, the state's largest urban area. The main streams in the basin are Lodgepole and Crow Creeks, which originate on the Eastern Slopes of the Laramie Range. These streams flow east in the basin before flowing into Nebraska and Colorado respectively. In Wyoming, approximately two-thirds of the annual natural surface flows (20,000 acre-ft) are depleted before leaving the state. Municipal and industrial users consume the greatest amounts of surface water in the basin. In addition, the Cheyenne Stage II water project delivers municipal water to the South Platte regions via an interbasin transfer from the West. Zone 3279 represents the Kiowa Creek drainage. Kiowa Creek is an ephemeral stream with little regulation. Although it usually has no flow, flows of over 600 cfs have been recorded. Irrigated lands in this zone rely upon groundwater. The aquifer is not part of the South Platte alluvial aquifer, but rather a confined, non-tributary aquifer identified as the Kiowa-Bijou Designated Ground Water Basin.

South Platte at Weldona
Streamgage POR: 1952-present
Annual Regulated Flows: 532,000
Annual Naturalized Flows: n/a

Zone 3216: Crow Creek
Area: 1,323 mi^2
Irrigation: 6,555 acres
Streamgage POR: 1952-present
Annual Regulated Flows: 9,800 at the state line
Annual Naturalized Flows: n/a

Zone 3279: Kiowa Creek
Area: 699 mi^2
Irrigation: 20,591 acres
Streamgage POR: 1960-64
Annual Regulated Flows: 3,500
Annual Naturalized Flows: n/a

Major Issues

Annual surface diversions for irrigation in this segment are 358,000 acre-feet, ranging from 218,000 to 450,000 acre-feet depending upon river flows, seasonal weather, and water rights calls. Inflows, from both irrigation returns and natural run-off, average around 100,000 acre-feet per year. The effects of groundwater pumping are difficult to quantify due to the hydrologic complexity. Overall, the annual flows at Weldona are about 200,000 acre-feet less than those at the upstream forecast point, KERC2.

Little of the flow from Crow Creek manages to get to the South Platte. The City of Cheyenne Wyoming diverts approximately 4,000 acre-feet for municipal use, with additional industrial and irrigation uses. The annual flow at the state line is 9,800 acre-feet, but most of this is diverted for irrigation in Colorado. Crow Creek is not gaged in Colorado.

BZNC2 – South Platte River at Balzac

Area: 1,668 mi^2
Irrigation: 97,392 acres
Upstream: WNAC2, ZONE 3236, ZONE 3271
Downstream: JULC2

Description

Flows in this segment are reduced by significant irrigation diversions. The water rights in the lower South Platte River are more junior than those in the foothills region, and thus rely upon irrigation and municipal returns from upstream diverters to sustain river flows.

Zone 3263 contains the Bijou Creek drainage and Zone 3271 contains the Badger Creek drainage. Both are ephemeral streams prone to large flood flows during intense rainfall events. Peak flows on Bijou Creek during the 1965 flood are estimated between 200,000 and 466,000 cfs (larger than the average flow of the Mississippi at St. Louis). Little streamflow regulation is present in either zone. Groundwater pumping from both confined and tributary alluvial aquifers provides water for irrigated farmland.

Streamgage POR: 1917-present
Annual Regulated Flows: 303,000
Estimated Naturalized Flows: n/a

Zone 3263: Bijou Creek
Area: 1,376 mi^2
Irrigation: 32,125 acres
Streamgage POR: 1952-present

Annual Regulated Flows: 9,800 at the state line
Annual Naturalized Flows: n/a

Zone 3271: Badger Creek
Area: 273 mi^2
Irrigation: 12,635 acres
Streamgage POR: 1960-64
Annual Regulated Flows: 3,500
Annual Naturalized Flows: n/a

Major Issues

Annual diversions for irrigation are 221,000 acre-feet for approximately 97,000 acres of farmland. Between Weldona and Balzac, the river loses an average of 98,000 acre-feet per year.

JULC2 – South Platte River at Julesburg

Area: 3,125 mi^2
Irrigation: 151,203 acres
Upstream: RALN1, BZNC2
Downstream: RSON1

Description

There are approximately 150,000 irrigated acres in this segment, primarily on lands parallel to the river. Both surface diversions and groundwater pumping are used to procure water. This segment of the South Platte is affected by the requirements of the 1923 South Platte River Compact. The main provisions of the Compact are:

1. Division of the waters of the South Platte River is accomplished by this compact between Colorado and Nebraska, with the consent of the United States Congress.

2. From the 15th day of October until April 1, Colorado has full use of the water of the South Platte River within the boundaries of the State except that Nebraska is entitled to divert surplus waters if the proposed Perkins County Canal is constructed.

3. From the first day of April to the 15th day of October, if the mean flow at the interstate station is less than 120 cfs, Colorado shall not permit diversions from the lower section of the river to supply appropriators with dates of priority subsequent to June 14, 1897.

Streamgage POR: 1902-present
Annual Regulated Flows: 460,000
Estimated Naturalized Flows: n/a

Major Issues

There are 22 major diversion structures in this reach, diverting around 180,000 acre-feet annually. Irrigation return flows and groundwater pumping can also affect river flows. Measured inflows from irrigation drains averages about 70,000 acre-feet per year. Annual gaged flows indicate that the Balzac to Julesburg reach tends to gain about 20,000 acre-feet per year, although it is highly variable, ranging from gains of over 100,000 acre-feet to losses of 80,000 acre-feet.

Colorado, Wyoming, and Nebraska have formulated the Three-State Cooperative Program to address threatened and endangered species in the lower Platte Basin. As part of the Platte River Recovery Implementation Plan, the State of Colorado has developed its initial water project (Tamarack I) to develop an average annual yield of at least 10,000 acre-feet during times of target flow shortages. The Tamarack plan would divert water during the high run-off periods into recharge facilities, from which water would percolate into the groundwater alluvium and return to the South Platte at a later time.

RSON1 – South Platte at Roscoe

Area: 716 mi^2
Irrigation: 2,827 acres
Upstream: JULC2
Downstream: PXTN1

Description

This segment is located mostly in the State of Nebraska. Nebraska administers water based upon a combination of the prior appropriation doctrine, reasonable use principles, and riparian water law. Apportionments, or allowable diversions, are issued by the DNR.

Streamgage POR: 1982-current
Annual Regulated Flows: 650,000
Estimated Naturalized Flows: n/a

Major Issues

By comparing similar periods of gaged flows, this reach of the South Platte gains an annual average of 30,000 acre-feet. Diversions in the segment average 23,000 acre-feet per year, attributable to the Western Canal.

PXTN1 – South Platte at Paxton

Area: n/a
Irrigation: n/a
Upstream: RSON1
Downstream: NPSN1

Description

This segment has a major diversion for off-channel power production at the North Platte Power Plant, managed by the Nebraska Public Power District. In 2000, the South Platte Supply Canal (decreed diversion rate of 500cfs) diverted over 50% of the river flows. Based upon streamflow analysis and discussion with Nebraska DNR, a large portion of the diversion is lost through canal seepage and returns to river upstream of NPSN1. Additional information has been requested, but the District has not responded to date.

Streamgage POR: 1939-1970
Annual Regulated Flows: 160,000
Estimated Naturalized Flows: n/a

Major Issues

The large diversions (over 40,000 acre-feet per month) at the canal are highly variable. In 2000, over 200,000 acre-feet were diverted off the river. In 2001, only 63,000 acre-feet were diverted. It appears that the diversions off the South Platte, usually occurring from October through May, are used to supplement the plant's diversions from the North Platte. After flowing through the plant, the waters from both the North and South Platte reenter the South Platte, just below NPSN1.

NPSN1 – South Platte River at North Platte

Area: n/a
Irrigation: n/a
Upstream: PXTN1
Downstream: terminal node

Description

There are no diversions in this reach, but there are large inflows as a result of upstream canal seepage. Based upon annual gaged flows, this reach gains about 86,000 acre-feet per year.

Streamgage POR: 1932-1994

Annual Regulated Flows: 298,000
Estimated Naturalized Flows: n/a

Major Issues

Based upon five years (1960-1964) of average monthly streamflows, the gain between the forecast points were consistently in the range of 100 to 150 cfs. More recent stream gage data should be evaluated (if available) to verify that the magnitude of gains has remained the same. Gains of 86,000 acre-feet would represent about 30% returns from the South Platte Supply Canal. This is feasible for an unlined canal.

Regional Issues

Administration of Water Rights and Effects of Downstream Calls

The appropriative dates of water rights in Colorado is such that the more senior water rights are located in the mountains and foothills, while the lower South Platte rights are the most junior. To some degree, this simplifies the modeling process. The main impact to upper basins is when the lower South Platte places a call for its direct decrees, thus ending the storage run in all upstream basins.

Trans-segment Effects of Diversions / Return Flows

There are several segments along the lower Poudre and South Platte rivers that pick up return flows as a result of diversions in an upstream segment.

Groundwater Pumping

The alluvial aquifer along the South Platte and its tributaries has a width of 1 to 10 miles and a thickness of 5 to 200 feet. Agriculture, municipal and domestic wells can yield up to 2,000 – 3,000 gpm where the sands and gravels are thick and contain only a small percentage of fine materials. Approximately 8 million acre-feet of water is contained in the South Platte alluvium. Recharge sources are precipitation, irrigation return flows, canal seepage, and seasonally from the South Platte River and its tributaries.

Quantifying Consumptive Use of Irrigation Water

A typical irrigation system with unlined canals and flood irrigation has a total system efficiency of around 50%. That means that 50% of the diverted water is actually consumed by the crop through evapotranspiration. Lands irrigated via groundwater pumping and center pivot sprinklers have efficiencies closer to 80%. Incidental use, or that portion of return flows that may be consumed by native vegetation or evaporation, is estimated at 10% of total returns.